# The Missing Link Between DQO's and MQO's

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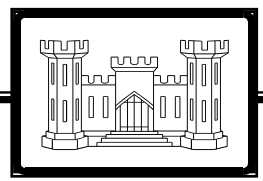


# Is Site Contaminated?

**Action Level (AL) = 100 ppm**
**True PCB concentration = 70 ppm**

**Will correct decision be made based upon some measured value, X?**

**Yes, if X = 70 ± 20 (50 – 90) ppm.**

**Maybe not, if X = 70 ± 40 (30 – 110) ppm.**

**Data Uncertainty ⇒ Decision Errors**

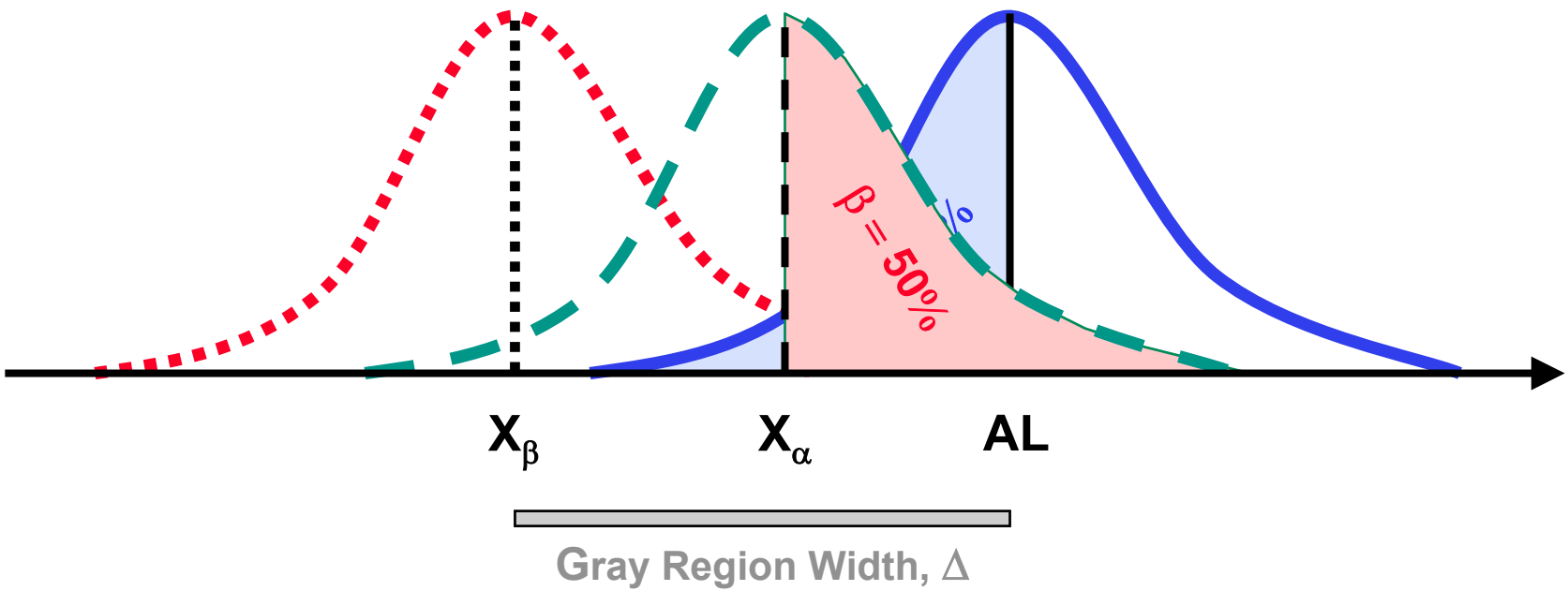
# DQO/MQO Process

EPA QA/G-4: "*Specify tolerable limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision.*"

**DQO ?⇒ MQO ⇒ Method ⇒ Lab**

# Data Quality and Uncertainty

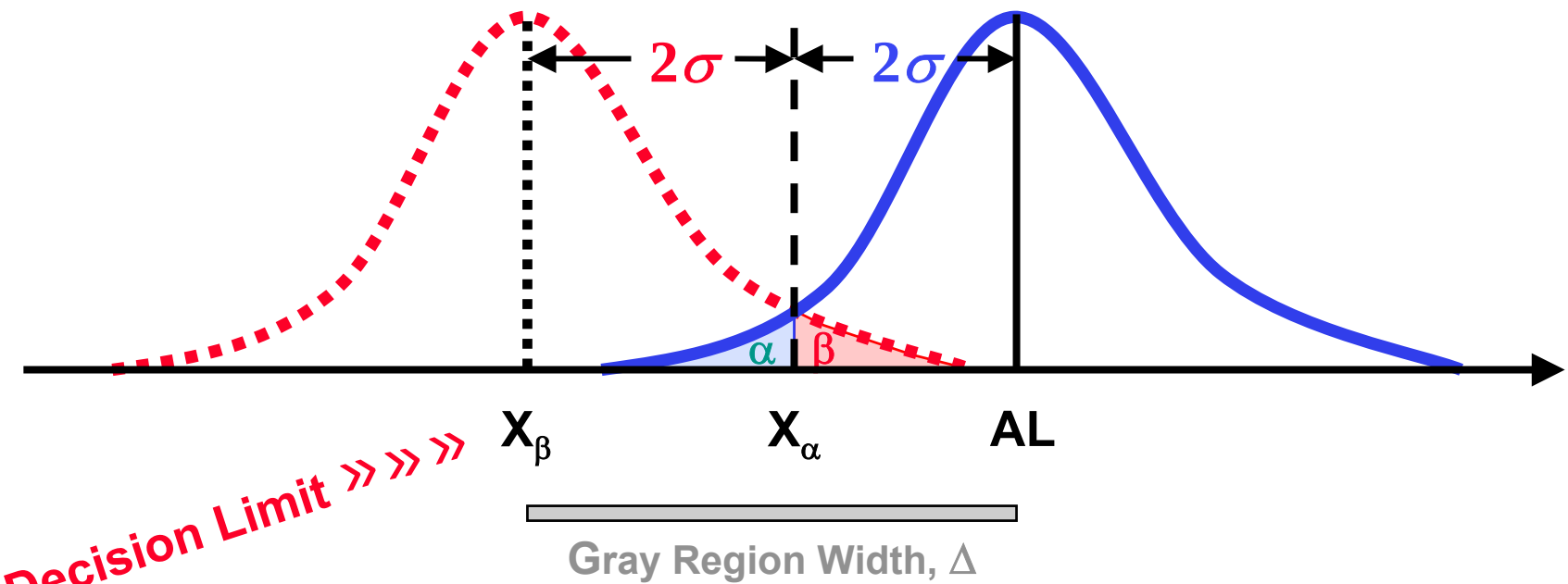
**$H_0$: $X \geq AL$, $H_A$: $X < AL$, Decision Errors ($\alpha$, $\beta$)**




$$\Delta = AL - X_\beta = f(\text{data quality, decision errors})$$

# Data Quality and Decision Errors

**$H_0$: $X \geq AL$, $H_A$: $X < AL$, Decision Errors ($\alpha = \beta = 0.05$)**




$X_\beta = AL - \Delta = AL - 4\sigma$, where $\sigma$ = std. dev.

**Site clean if $X < X_\beta$** but **$QL \leq DL = X_\beta$**

# DQO ⇒ MQO

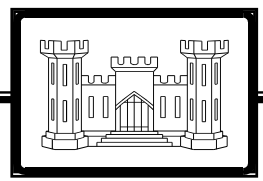
- **Requirement:** QL ≤ DL ($X_\beta$)
- **Project Inputs:** DL ($X_\beta$)

  Action Levels (regulatory/background level)

  Tolerable Decision Errors ($\alpha$, $\beta$)
- **Lab Inputs:** QL

  Method Detection Limit (MDL)

  Data Uncertainty (precision, bias)



# Selection of Contract Labs

- **Total Error ($\sigma$) =** $\sqrt{\sigma_{Lab}^2 + \sigma_{Field}^2} \geq \sigma_{Lab} \approx \sigma_{LCS}$

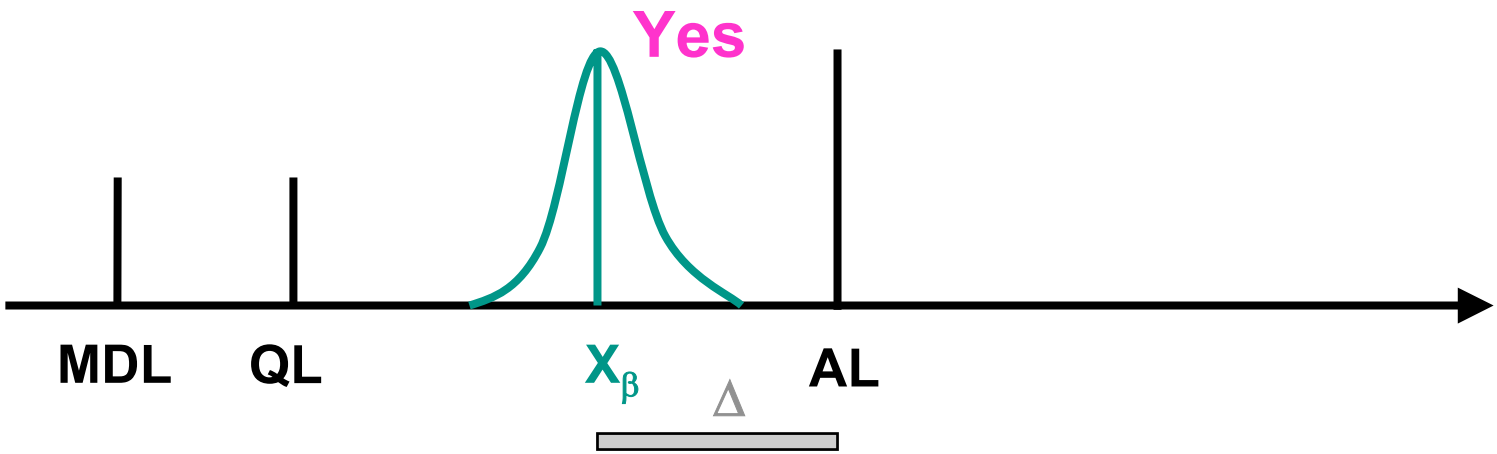
- **Assumptions: Labs have different performance for precision, bias, and detection limits.**

**Lab A: MDL = 2 ppb, QL = 10 ppb, $\sigma_{LCS}$ = 5%. $$$**

**Lab B: MDL = 4 ppb, QL = 20 ppb, $\sigma_{LCS}$ = 10%. $**

# Example 1: Lab A

**DQO: Determine if organic contamination is greater than AL = 30 ppb with $\alpha = \beta = 0.05$.**



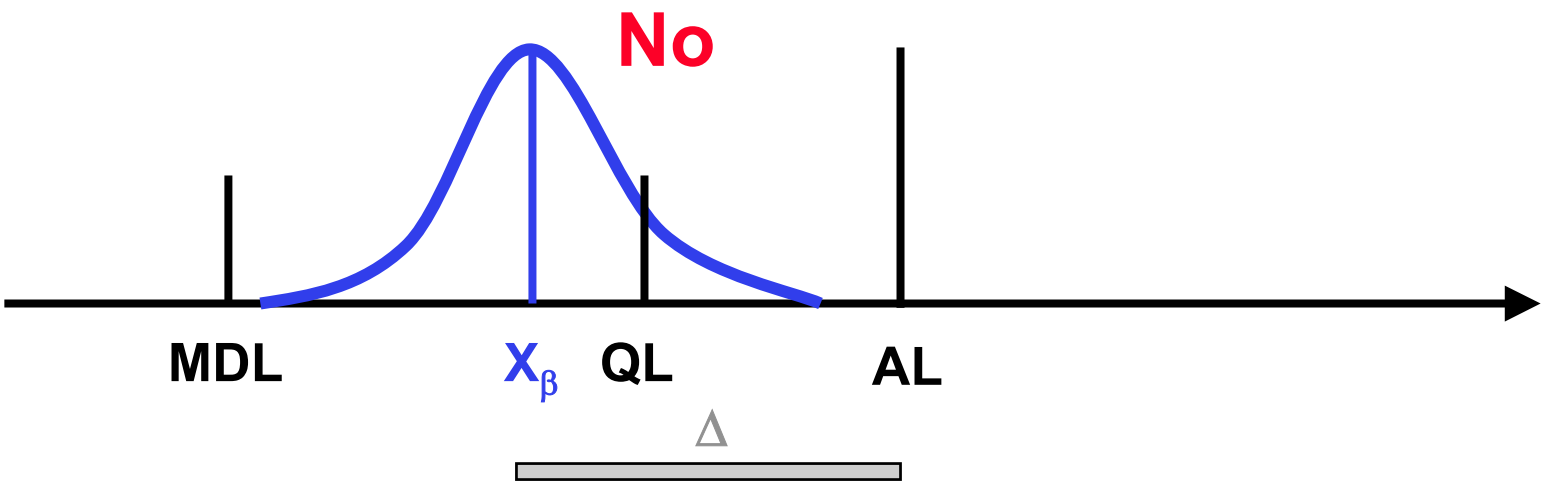

**Lab A: MDL = 2 ppb, $\sigma_{LCS}$ = 5%. Acceptable?**

$X_\beta = AL - \Delta = AL - (4 \times \sigma \times AL) \approx 30 - (4 \times 5\% \times 30)$

$= 24 \text{ ppb} > QL = 5 \times MDL = 10 \text{ ppb}$

# Example 2: Lab B

**AL = 30 ppb, $\alpha = \beta = 0.05$**

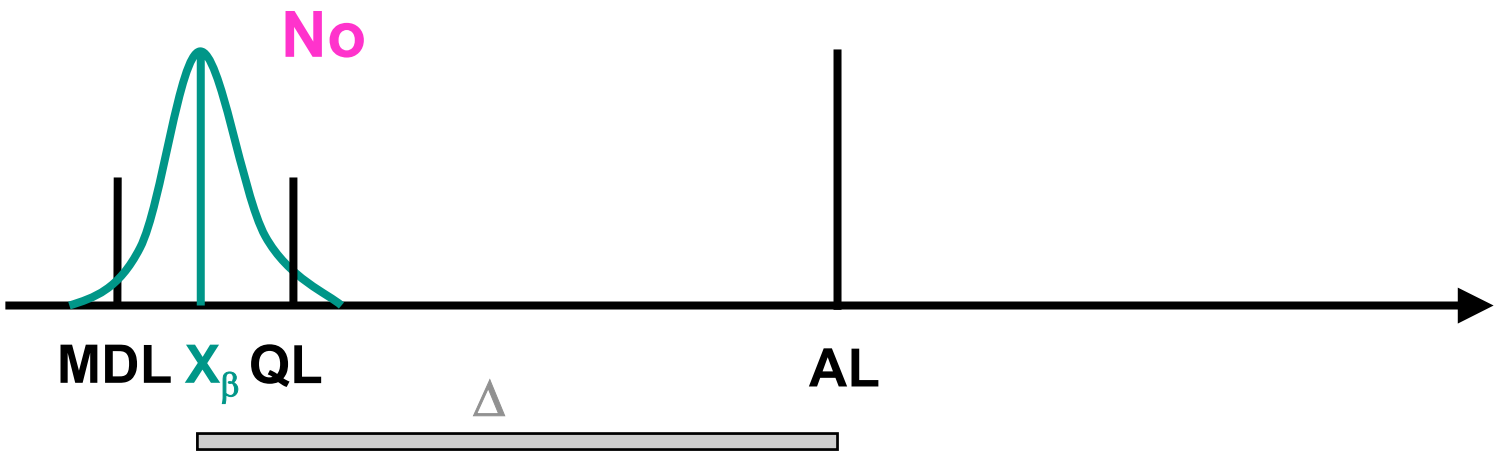



**Lab B: MDL = 4 ppb, $\sigma_{LCS}$ = 10%. Acceptable?**

**$X_\beta$ = 30 – (4 × 10% × 30) = 18 ppb < QL = 5 × 4 = 20 ppb**

# Example 3: Lab A with Large Bias

**DQO: Determine if organic contamination is greater than AL = 30 ppb with $\alpha = \beta = 0.05$.**



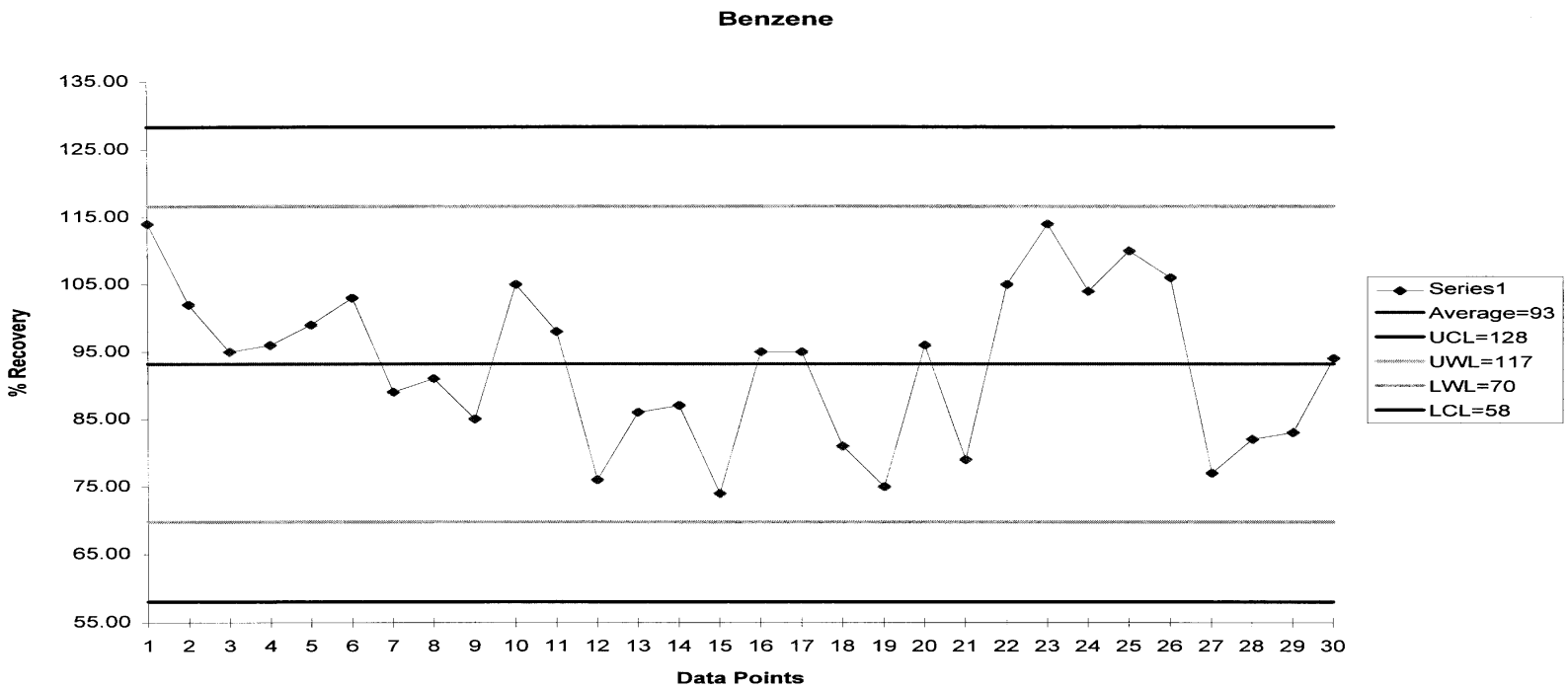

**Lab A: MDL = 2 ppb, $\sigma_{LCS}$ = 5%, $\overline{R}$ = 30%. Acceptable?**

$$X_\beta = AL - \Delta = AL - (4 \times \sigma \times AL) \approx 30 - (4 \times 5\% \times 30)$$

$$= 24 \text{ ppb} \Rightarrow 7 \text{ ppb} < QL = 5 \times MDL = 10 \text{ ppb}$$

# LCS Control Chart ($R$, $\sigma_R$)

Water Matrix LCS Recoveries BTEX - 1997



# Estimated Uncertainty

$$U = \frac{C}{R/100} \times \left[1 \pm t \times \left(\sigma_{LCS} \pm \frac{t \times \sigma_{LCS}}{\overline{R}}\right)\right]$$

$C$ = measured concentration

$\overline{R}$ = mean %$LCS$ recovery

$t$ = Student's $t$ factor, $t_{(n\text{ -}1,1\text{-}\alpha/2)}$

$\sigma_{LCS}$ = standard deviation of $\overline{R}$ (%)

# Example: Uncertainty for Ni Data

**Lab: MDL = 10 ppb, LCS CLs = 75 – 105%.**
**What is minimum $U_{95\%}$ of Ni at 200 ppb?**

$$U_{95\%} = \frac{C}{\overline{R}/100} \times \left[1 \pm \frac{t \times \sigma_{LCS}}{\overline{R}}\right]$$

CLs = 90 ± 15%, $\overline{R}$ = 90%, $\sigma_{LCS}$ = 5%

$U_{95\%} \approx (200 \text{ ppb} / 0.9) \times [1 \pm 2 \times 5\% / 90\%]$

$\approx 222 \pm 25$ ppb

# Issues or Concerns

- Bias Correction
- Matrix Interferences
- Field Errors
- Consistent  Lab Operations
- Regulatory Acceptance

# Summary

- Simple and practical approach for determining the minimum MQOs based on DQOs.
- Useful tool for screening contract labs prior to contract award.
- Estimate the lower bound of laboratory data uncertainty.
- Need consistency in determining and reporting MDL and LCS control limits.
- Need regulatory acceptance.